(pre-print draft)

Notes on More-than-Human Architecture

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Introduction[1]

What can the creation of artificial habitats to replace old-growth forests tell us about the process, value and future of design? This chapter takes a concrete and provocative example and demonstrates its implications for modest, engaged and imperfect processes, which, it is argued, call for the rethinking of design as a gradual, ecological action. To illustrate this understanding, the chapter begins with a description of a proposal to provide artificial habitats for wild animals. The action of designing these habitats, which includes replacing rapidly disappearing old-growth trees with artificial structures, puts in doubt habitual assumptions about the clients, procedures and goals of design. This example is of relevance to all design for at least two reasons. Firstly, because the task of providing artificial habitats to nonhuman forms of life is going to become increasingly common as the environment requires more management under the influence of such phenomena as global warming or urbanisation. And secondly, because all design necessarily impinges on existing ecosystems and should aim to benefit nonhuman as well as human stakeholders.

The creation of artificial structures in place of natural habitats is described in this chapter as an incitement that highlights the need for further collaboration, for the integration of existing knowledge and for new research. With the resulting questions in hand, the chapter proposes the need for practice-oriented reconsiderations of values, participants and methods of design. It concludes with a proposal for an attitude of modesty in the face of the overwhelming (available

[1] Acknowledgement: ideas in this article have been developed in with Gwyllim Jahn and their discussion in application to technical systems can be seen in a collaborative journal article (Roudavski and Jahn, 2016).

and incoming) information as well as in the presence of an even greater and sometimes unbridgeable ignorance induced by interactions with nondeterministic, volatile and incompletely controllable natural systems (Merchant, 2016). The dilemma of design in these conditions is in the tension between its remit to act, and act now, and the uncertainty that inescapably underlies any purposeful change and any creative endeavour.

Design Challenges

> [A] tree is not easily defined or at least is definable in many different ways. (Hallé, et al., 1978, p. 1)

This chapter argues that design encounters one important and insufficiently understood challenge: the need to design for all biosphere, for all life, within ecosystems. To illustrate this challenge, this section refers to an approach that proposes to design artificial habitats for nonhuman clients that live in the trees. This type of project is a largely uncharted ground, so the purpose here is not to share ready recipes or advocate for best practices but, instead, to challenge habitual approaches to design so that they could be reconsidered from first principles.

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When large trees are lost – to harvesting, agriculture, safety concerns in urban environments or other causes – tree-dwelling animals such as birds, bats and insects lose their habitats and the local ecosystem disintegrates. The planting of new trees to replace the old ones does not resolve the problem because the young trees cannot provide appropriate conditions (Gibbons and Lindenmayer, 2002; Le Roux, et al., 2015). Large trees take hundreds of years to mature and develop adequate habitat features such as large canopies, cavities, fallen branches and peeling bark. The combined effect of such features makes large old trees function as biodiversity hotspots or ‘keystone structures’ in the surrounding ecosystems (Manning, et al., 2006). The tree example is far from unique. On the contrary, the presence of suitable physical structures is important to many forms of life in a broad variety of situations. For example, wetlands (Tews, et al., 2004) and reefs (Kerry and Bellwood, 2015) also act as keystone structures in their ecological systems.

When a large old tree is gone, a replacement for it might be provided artificially. Provision of artificial habitats has been attempted in marine environments, for example, in the case of artificial reefs (Baine, 2001) and in other marine structures built as ecological habitats (Bulleri and Chapman, 2015) including artificial shorelines (Browne and Chapman, 2011), fish aggregation devices and artificial seagrasses. More recently, this approach has been attempted in the work of Le Roux for the Australian Capital Territory’s Parks and Conservation Service, with artificially constructed props or reused dead trees. It is likely that such artificial replacements of natural structures will be increasingly necessary, or at least conceivable, as viable tactics in the challenge of managing environments. Artificial objects can and already do support many species and should be taken into account in the work of conservation, regeneration and management of novel ecosystems. Such incorporation will require further research on how such structures impact the environment and relate to the functioning of human societies.

The job of providing habitat structures is familiar to architects whose profession is expressly dedicated to the regulation of dwelling, typically through physical structures. However, the established architectural-design practices focus on human needs and judge designs according to human criteria for success. If this anthropocentric focus is abandoned, the goal of facilitating habitation for all life emerges as a logical broadening of existing architectural work. However, the implementation of such broadening is far from trivial and requires further theorisation and practical experimentation.

Design Contributions

> "Far more important [than creativity] is being mindful of all those who have or may have an interest in valuing what has already been created." (Sless, 2012)

The challenges of design that integrates into ecosystems is already taken up by a range of disciplines including ecology and engineering. The names of relevant subfields proliferate: environmental engineering, biotechnology, ecotechniques, cleaner technology, industrial ecology, synthetic ecology, biomanipulation, restoration ecology, river and lake restoration, bioengineering, wetland restoration, sustainable agroecology, reclamation ecology, habitat reconstruction, nature engineering, ecohydrology, ecotechnology, ecosystem rehabilitation, engineering ecology, biospherics, solar aquatics… And yet, as the specialists readily acknowledge, the productive communication between disciplines predominantly responsible for understanding (such as ecology) and those mostly responsible for action (such as engineering) is insufficient (Mitsch, 2014). In these conditions, what can design disciplines proper, such as architecture, contribute in addition to the scientific and technical work already under way?

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From corporate skyscrapers in the desert to sport cars on public roads and throw-away smartphones, design can be seen as an exuberant expression of consumerist excesses. Understood as such, design is a practice to overcome, with time and at a cost, like fossil-fuel energy sources or plastic bags in supermarkets. It is a burden for the ecology, what Ingersoll calls "building against nature" (2012, p. 574) and Tonkinwise proposes to design out of existence (2014, p. 198).

This chapter takes a contrasting standpoint that sees design as (firstly) an unavoidable and (secondly) a potentially useful set of practices. This optimistic appreciation dissociates design from the making of desirable products and, instead, sees it as a practice that investigates the unknown by sampling possible future states. This understanding is concerned with situations where the path from the existing conditions to a preferred future state is not known; if the necessary steps are clear, designing is not required. This type of designing occurs in many existing fields, such as those already mentioned above. For example, many aspects of scientific work require designing but the primary emphasis in physical, natural or social sciences is on the study of the existing world. Where such studies focus on a proposal for the future, for example in many subfields of engineering, the scientific methods become supplanted by or complimented by those typical for design.

This understanding is an effort to abandon associations of design with fussy cleverness that creates a world where everything is overdesigned, or exclusivity that helps to sell luxury. By contrast, design can mean "designing of nothing" (Fry, 2008, p.71) and this chapter highlights the outcomes of design that are to do with systemic changes rather than with material objects. For example, a prosthetic habitat might be valued as an object but its primary purpose is to bridge a gap in a habitable world left by a felled large old tree, ideally disappearing after the job is done or, at least withdrawing into a modest, supporting role. In this case, the outcome is a self-supporting autonomy of an ecosystem. Design can also mean metadesign (e.g., see Wood, 2007),understood as a mode of politics that seeks to go beyond that which is commonly thought possible. This attitude might choose to create an artificial habitat that is deliberately provocative, not to achieve a desirable commodity but, instead, to solicit an informative response or campaign for attention and care. The outcome of such design might be intentionally grotesque, morally questionable and, sometimes, not fully functional, only imagined and or even impossible.

Design Values

"[N]ature is not natural and can never be naturalized[.]" (Harman, 2005, p. 251)

The reorientation of design from commodities, conveniences, prestige and associated marketing towards moral issues: choice, constraints, sharing, fairness or justice necessitates an engagement with values, a kind of design-philosophical experimentation. The purpose of such experimentation has to be stretch-testing or replacement of the familiar concept in the actual field conditions of today, and – more importantly – of tomorrow.

To illustrate, the idea of 'nature' is one of such concepts, obviously central to the above challenge of providing artificial replacements habitats. And yet, "[r]estoration of wild places in the Anthropocene depends on valuing multiple forms of wildness, including novel anthropogenic forms that have yet to be imagined." (Cantrell, et al., 2017) As Fry remarks (Fry, 2012, p. Part II.6.Passing Figures of Technology), "'we' now exist in two kinds of intertwining 'natures': the biological and the technological. Both 'natures' are governed by specific but inherently internal processes (over which 'we' have very limited and diminishing control)." This diminishment of control stems from the intrinsically unpredictable behaviour of such complex systems as societies, technologies or nature. In itself, humans' inability to attain full control is not positive or negative. It can be experienced as a form of liberation from the drive to some all-unifying approach but can also be threatening with impending large-scale disasters such as those that might be triggered by continuing global warming. In these conditions of limited control, it is necessary to move from mechanistic accounts of the environment to a consideration of its ongoing autopoiesis in the context of extended hybrid communities. The reframing of design practices that is necessary for this move will shift attention from human-centred design to more open-ended goals that will imply rethinking the very composition of the world and can thus be described as ‘ontological design’.

Given that all technology emerges through design, it is also useful to acknowledge that entities created through designing exert influence in ways that extend well beyond specifications imposed by design briefs. As evidenced by recent trends, for example those that emphasize strategic design or social innovation, the common view that the primary role of designers is to solve local problems for concrete clients is already becoming less influential. For example, Sanders and Stappers (2012) re-describe designers as user-centred creators informed by ethnographic research. However, ergonomic and human-centred design that focus on ‘users’ can also lead to the negative effect of defuturing (a depletion of future options and shortening of the future life), for example when it is employed as an agent of consumerism (Fry, 2008, p. 53, 54). As will be discussed below, who or what can be counted as a user is open to questioning; along with what might constitute legitimate, desirable or sustainable ‘use’. In the context of ecological relationships, the very concept of ‘use’ appears to be suggestive of outdated, exploitative attitudes towards the environment. To move beyond understandings that are confined by such instrumentalist interpretations or by existing political and economic paradigms, designing needs to be reconsidered, for example, as an elemental, ontological practice (cf. “ontological design”, (Willis, 2007), behaviour-steering technology (Jelsma, 2000), transformation design (Burns, et al., 2006) or persuasive technology (captology) (Fogg, 2003)).

What are the key concepts relevant to an ontological practice that aims to imagine cross-species habitats? For example, are characteristics typically applied to ecosystems, such as biodiversity, useful in this regard? As it is evident from recent overviews (Garson, et al., eds, 2017), concepts such as this are still in active negotiation. Multiple definitions of biodiversity coexist. There are parallel applications of this concept across scales such as genes, organisms, species or ecosystems. Its pragmatic effects on conservation are often driven by human preferences for valuing some charismatic forms of life, such as elephants, more than others, such as microbes, or viruses, or genetically modified organisms. To provide an alternative example, some of the more recent approaches understand rewilding as a measure of human-independent autonomy that can be sustained by the artificially composed ecological systems that might be appropriate, for example, for the increasingly abandoned agricultural land (Cordell, et al., eds, 2005; Corlett, 2016). These concepts seem to suggest that the ideal replacement tree should be ephemeral: temporarily present, dissemblable/decomposable or, even if it is harder to imagine: autonomously mobile, energy independent and self-repairing.

Diversity is commonly used as a generic characteristic or 'natural way' but resolving it into a set of design principles is far from straightforward. Nature is typically admired in contemporary design circles because it "produces maximum effect with minimum means" (Kolarevic and Klinger, 2008, p. 10). And yet, the idea that ecologies are finely balanced or wasteless is "bad poetic science" (Dawkins, 1998). As a category, 'waste' is of course a human invention and an expression of human values. Still, if some can see nature as wasteless, others may point out that nature is wasteful in many ways. For example, it is wasteful of energy as only a small portion of incoming solar radiation is used by life and living organisms dissipate energy constantly; nature is wasteful of individual lives, with survivors often only making it by chance; and nature is wasteful of innovation because local discoveries are eliminated by natural selection in the periods when the environment does not change significantly and in the process, most of innovations are lost.

In these conditions, how should diversity be valued? As a unique, as-found, snapshot of long and unique historical accumulation? This attitude presumes that the historical processes that lead to the current state can be arrested, which does not appear to be the case. If diversity is to be valued as an effect of the underlying processes (e.g., selection, drift, speciation and dispersal at the level of community ecology (Vellend, 2010)) it needs to be accepted that it comes coupled with other phenomena such as blind opportunism or indifference to human concerns. In this context, what happens to recognizable human criteria and values such as comfort, safety, reliability or efficiency? In a field with other actors and values, what new guidelines and criteria are needed or even possible?

How can foundational concepts be utilized to generate the practical criteria for design? For example, is biodiversity measurable? Can these measurements be standardized and made simple enough to operate in the context of a design project? Existing strategies for habitat restoration recommend that each project should start with an establishment of a goal state. The desired characteristics for such a habitat are often a compromise between the states of indigenous landscapes and other interests, such as agriculture. However, most landscapes have been affected by human actions for thousands of years. Many living forms depend on environments affected by humans and some might have evolved within them. This interdependence is especially prescient in the contemporary conditions where most living organisms, at least on land, have to live among artificial structures such as roads, dams, buildings and so on (Cronon, 1996 [1995]; Low, 2017 [2002]; McKibben, 2003 [1989]; Wapner, 2010). If the return to the pre-human state is impossible or not desirable, what are the suitable criteria for alternative goal states?

In the case of artificial replacements for old large trees, the resulting landscape can be directed to very distinct visions. In principle, one can aim to actively maintain a model of “wilderness” that conforms to the biodiversity found in historical records or in less disturbed pockets of bush. However, in many cases this is no longer possible, for example in the cases of commercial forests intended for harvesting or in fragmented landscapes. In spite of this, the idea of artificial replacements for trees is met by intuitive repulsion and skepticism by many unprepared people. For them, a confirmation that such trees are only intended as a temporary prop that supports animal life until the natural trees are large enough is a necessary (but not necessarily sufficient) justification. However, in many environments, the large trees are not coming back. And even in the environments where they might return, introduction of artificial structures specifically designed to provide ‘modern conveniences’ to animals might result in new preferences and dependencies that will make a return to natural trees difficult or impossible. Dependencies on anthropogenic environments are now common for many species, including those listed as endangered. Examples include barn swallows, sparrows, urban foxes and many other animals that prefer habitats modified by humans to wilder places even if these environments have not been constructed with these animals’ needs in mind (Low, 2017 [2002]). Thus, introduction of artificial replacements, especially at scale, can shift an existing environment to a substantially altered state and potentially result in a cascade of hard-to-predict effects. A design impulse towards ‘nature’ might lead to another form of complex artifice.

Design Participants

> "[I]t is an unavoidable feature of our narratives about human-technological systems that we are always faced with a contested ambiguity between human and material causation." (Galison, 2000, p. 39)

Acceptance of the responsibility for anthropocentrism's pervasive environmental impacts can arrive through the understanding of how the concept of human was invented. The relevant discourse on post-humanism, and its objective of "going beyond humanism's limit(ations)" (Fry, 2011, p. 245), is well established and design practices can benefit from rethinking their objectives and methods to take this into account.

One way to approach this rethinking is though studies of the roles technology plays in human performance and the suggestion here is that such studies can productively move from the invention and appraisal of tools to the analysis of humans enmeshed in technological ecologies. To illustrate, such analyses can vary from in-depth observations of how meaning emerges in low-level material interactions (Jahn et al., 2014), to utilization of 'living' models, as discussed in a precursor to this article (Roudavski and Jahn, 2016), to broad considerations now attempted in 'software studies' (e.g., Bratton, 2015).

Another way to shift the attention from the stereotypically understood human stakeholders is through the deliberate inclusion of more-than-human entities. However, the rationale for such inclusion and the procedures through which participation can be undertaken are far from settled. Identity and agency of such participants cannot be taken for granted and modes of communication with such entities are far from obvious. The processes of negotiation that can account for diverging tendencies of human and other stakeholders are not yet available and call for substantial further work in philosophy, politics and ethics as well as in design.

What can be counted as an actor is open to interpretation leading to frameworks discussed as 'flat' or 'weak' ontologies. In the context of design, who or what are the legitimate or simply meaningful 'clients'? Should client representation resolve itself at the level of genes, organisms, superorganisms, species, biomes or other possible structures? Should such clients be living, semi-living or defined in some other manner? To illustrate, traditionally, architects and biologists considered structures as objects and functions as processes. The increasingly influential alternative view (Odling-Smee and Turner, 2011) regards living structures as processes. For example, habitats created or modified by animals can be seen as constructed ecological niches (Odling-Smee, et al., 2003) or physiological extensions of animals' organisms (Turner, 2000). Consequently, human architecture can also be seen as living (Turner and Soar, 2008). In a contrasting move, human beings can be seen not as primarily biological entities but as actors that are designed and constructed through the cultural use of technology (Fry, 2012). In the time when rivers can obtain legal personhood and the requisite rights (Hutchison, 2014): who are the makers?, who sits in judgement?, who stands to benefit?

When understanding a template habitat structure, such as an old large tree, that a newly designed artificial object is to replicate, what characteristics are important? Height, girth, crown spread, trunk and branch volume, canopy structure, canopy volume, and overall tree shape can be considered, as is typical when measuring large trees for record books. These can be complemented with the information on the functional affordances such as numbers and types of nesting and perching sites as well as the information on the typical inhabitants such as birds, invertebrates or fungi.

Who (how and when) can collect or provide such information? Comprehensive information is not available and the amount of information to describe a habitat such as an old large tree can be overwhelming. Existing information tends to come from sources that have compiled the records for specific goals, for specific groups of organisms, specific geographic locations and via a variety of methods that produce hard-to-merge datasets. Theoretical biologists might study how formal fractal systems can describe botanical structures, preservation societies are interested in listing all old trees and finding record-holding champions, ecologists might evaluate reliance of one threatened species on the density of suitable hollows. Established architectural types and typical architectural procurement and vetting methods need to be extended so that this disparate knowledge can more readily inform architectural design and be translated into concrete proposals for action.

In the case of artificial replacements for large old trees, the argument for the preservation of biodiversity is generated by the ecology experts. Governments might be supporting similar goals, for example through biodiversity offsets, a scheme that seeks to compensate for habitat losses caused by economic development, such as new construction or wood harvesting. Advocates for biodiversity argue, that the “aim to protect the ecological values of existing and future urban areas, as well as adjoining habitat such as peri-urban nature reserves, should be articulated during the planning phase and carried through the full development process.” (Ikin, et al., 2015, p. 207) However, where ecosystems have been already radically altered, where the balance is severely skewed or where some of the ecosystem members are unwanted by humans, framing the problem as preservation might be misleading and the actual challenge is the establishment of some novel state. To differing degrees, this problem is typical, given that no ecosystem on the planet can now be classed as unaffected by human activities. Thus, even if a commitment to “ecological values” is achieved at the planning stage, the problem of design remains, as is evidenced by the diversity of possible designs occurring within the confines of comparatively more mature architectural or urban-planning guidelines. Furthermore, innovative design often helps to determine what is possible and desirable in planning. Thus, innovation, across all aspects of design including stakeholder inclusion, processes and outcomes is needed even if the overall goal is to be modest. The challenge of designing artificial habitats such as synthetic replacements for large old trees can be very controversial, especially if the resulting structures are large and numerous. Therefore, the appropriate design approach will have to focus on the challenges of building visions of the future supported by persuasive narratives as well as on the generation of engineering solutions. The appropriate practices fall under the rubric of participatory design. However, the human imagination and innovation alone will not suffice when the benefits are to be shared by all life and this challenge takes form of expanding contemporary understandings of participatory design to become more radically inclusive, from the design for nonhumans to the design with them.

Design Methods

> "It is difficult, either for an individual or a society, to plunge full speed ahead into the future while braking to keep pace with a biological past." (Gunter, 1985, p. 107)

The recognition that practical design necessarily participates in ontological-design processes invites an abandonment of the concept of creativity understood as an agency directed from within a human creator and out into the world. At the moment, even the inclusive interpretations that make an effort to emphasise the distributed character of creativity and acknowledge the ever-present involvement of heterogeneous agents, including nonhumans, focus on modifications introduced into the environment rather than on the inevitable simultaneous destruction of prior conditions. And yet, this necessary characteristic of creativity is important in a world where impossible-to-replace and emergent conditions, such as cultural or biological diversities, are being diminished with increasing speed and replaced with intentional human creations. In response to this conceptual omission, this chapter suggests a shift from the notion of creativity as the process of addition to its interpretation as the process of restructuring, or – in other words – a shift from creativity as an ingenious human 'making' to more modest metaphors that emphasize continuity of the world's processes, such as metamorphosis, or evolution. This alternative way of seeing can adjust the orientation of design practice by exposing the need for methods with the ability to transform whole networks of habits and routines (Bourdieu, 1990).

In the available world, all making is necessarily prefigured by the already-existing context that one can choose to emphasize as nature, modified nature, artificial entities experienced as natural or artificial entities that are unmistakably artificial. A complete understanding of this complex mix is not yet available. Given the constant change and the inherent unpredictability of the multifaceted systems at play, such an understanding is also impossible.

This realisation, then, suggests a deliberate position of what Sadar calls "age-old virtues: humility, modesty and accountability" (Sardar, 2010, p. 442). The current societal and environmental conditions have been described as a transition into post-normal times where established systems are coming under pressure (Funtowicz & Ravetz, 1993; Montuori, 2011; Sardar, 2010). This uncertainty is further amplified for designers whose specialisation is to do with inherently wicked problems where the resources are incomplete but the decisions are expected. These designers are unavoidably constrained by the human mind's excessive love for meaningfulness and certainty (Burton, 2008) making generation and the acceptance of adequate proposals more difficult. In these conditions, a deliberately modest attitude frames research as a necessary and permanent part of design intended to reduce ignorance rather than to produce knowledge (Wagner, 1993) and resulting in the “ignorance-based worldview” (Vitek & Jackson, 2008), that emphasises the limits to human knowledge and human control while cautioning against short-term action, as the foundation for design.

Such a worldview can foreground the understanding of design as activities of redirection rather than an inherently creative or innovative endeavor. Amid such activities, designers assume the role of mediators responsible for exchanges between multiple stakeholders, human and nonhuman, natural and artificial, living and non-living.

This shift in attitude can be characterized as a turn towards opportunism: from pre-planning to ambiguity where decisions are made in the process of making, in the context of actual sites and in response to available information; from central control to local diversity where decisions are responsive to changing contexts; and from performance thresholds to adaptability where decisions are made in response to incoming information about the environment and the effects of past actions. To enable such a turn, architectural design and construction workflows need means to observe the dynamic behaviors of host systems, understand relationships within these systems and trigger on-demand, local actions.

The focus on modesty and the acceptance of imperfection are the basic premises of conservatism. And yet, conservatism, that is also about preferring familiar to the unfamiliar, is a direction without the tools to answer the key question: how can one behave modestly in post-normal times where the radical change is inevitable and the familiar is unsustainable?

What types of structures might be used to produce artificial habitats? Depending on what is selected as important design criteria, the results might look very different. For example, artificial reefs are often made from scuttled ships, tires or even old tanks and airplanes. While this approach might be functionally adequate, from a standpoint of an architectural designer it looks like a missed opportunity, potentially leading to culturally unsustainable structures, even if under water, but especially on land. Existing resistance to the erection of such constructions as wind turbines demonstrates what might happen. The space of possible structures remains largely unexplored. Artificial trees might attempt to resemble their biological prototypes as closely as possible or appear very different from them while providing some of the desired affordances. As in many situations, it is likely that artificially constructed habitats can be made more economical, impactful and culturally acceptable if biomimicry approaches are combined with technological innovations. This challenge stands out as an opportunity for design disciplines with their emphasis on open-ended practical experimentation, their awareness of the wide spectrum of possibilities, for example in regard to geometric and structural arrangements, and their proficiency in working with disparate datasets, stakeholders and values.

Connected with the above, the design and making processes that lead to the construction of artificial habitat structures such as large old trees can be based on human imagination or generate unusual structures semi-automatically, in response to criteria and constraints. Data-driven, performance-oriented, algorithmic and computational approaches are interesting in this regard because they have the capacity to distance human designers from design outcomes providing a conceptual space for splicing in other creative influences. A nonhuman stakeholder such as a bird or a marsupial cannot be asked directly about their habitat preferences, at least not in English (or in, say, Woiwurrung). The challenge of including their voices into the design process requires innovative approaches based on observational data.

How can such structures be built, used and decommissioned? Artificial replacements for real trees might be useful because they are quick to construct. This is their main, but not only, potential advantage over naturally grown trees. However, as a result, they cannot grow and decompose in the same way that natural structures do and thus require considered strategies for production, assembly, modification, disassembly, reuse and recycling. The establishment of guidelines for longevity, location and prominence of artificial structures existing as prosthetic but functional members of ecosystems, as well as cultural artefacts, is a separate challenge with unobvious criteria for success or risk management.

What is the feasibility of artificial habitat replacements? How should the value and risk of such projects be established? Should artificial habitat structures be valued, perhaps even costed, in comparison to the natural structures they replace or for the ecosystem services they can provide? Can (and should) such projects be undertaken at scale and with what additional implications?

How can generative design approaches affect public reception of artificial habitats? Can the public be better persuaded when the information on the existing trees, their appearances and their affordances are compared with the information on artificial habitat structures and effectively narrated? For example, the public can be given an opportunity to observe and follow the self-design and recovery processes instigated or assisted by synthetic structures. With contemporary interactive technologies, this participation can be local or remote, real-time or asynchronous, as desired. This information can be framed as stories about specific characters, or games, or provided as some form of ambient information that links typical human habitats with the dwellings of other animals. In the context where the strategies are unusual and the outcomes are not necessarily evident or intuitive, the design of engagement strategies in parallel with the design of a material intervention is necessary for the attainment of a lasting cross-species partnership.

Admission of nonhuman clients and partners has the potential to further reinforce the quantitative turn in design and planning. This turn has been predicated by the increasingly widespread commitment to sustainability, wellbeing and other performance targets that prescribe technical and financial audits, energy models, performance codes and rating systems. These measures aim to outmode unsustainable architecture and promote best practice but, given the broad reach of national and international auditing schemes, can have a standardising effect on design. With the focus on statistical data describing behaviour and preferences of ecosystem participants, such standardising effects can be further amplified. On the other hand, the recognition of the local, spontaneous and non-repeatable character of ecosystems can help to reinforce the unique features of habitats, especially with the help of on-demand, context-specific data collection and deliberate reliance on alternative sources of creativity such as the capability of ecosystems for self-design or the idea of partnering with nature (Odum, 2007; Van der Ryn and Cowan, 2007 [1996]).

Conclusion

> "[Y]ou confuse two things: *solving a problem* and *stating a problem correctly*. It is only the second that is obligatory for the artist." Chekhov, in a letter from 27 October 1888, while agreeing that artists need to adopt a reflective attitude towards their work. Translation by Constance Garnett.

"[H]ow can designers join things together again if they continue to be educated, and employed, as profit-enhancing specialists, rather than ecologically and socially-minded generalists?" asks Wood (2008, p. 2) His own answer is that "[d]esigners […] need to cocreate a discourse that enables everyone to understand things in a more holistic and relational way." (Wood, 2007) A variety of parallel approaches already exists, including, for example, design activism (Fuad-Luke, 2009) and metadesign (Giaccardi and Fischer, 2008; Wood, 2008).

Redirective practices of this type aim to reshape what a designing subject is, knows and does. Such practices seek to modify how people think about familiar or future phenomena. Given the problematic (unsustainable) nature of many established approaches, redirective efforts need to challenge the very basic assumptions. As argued by Fischer (Fischer, 2003, p. 89),"[u]ser-centered and participatory design approaches have focused primarily on activities taking place at design time", neglecting to support "systems as living entities that can evolve over time." In response, his interpretation of "metadesign" is as "a unique design approach concerned with opening up solution spaces rather than complete solutions (hence the prefix meta-), and aimed at creating social and technical infrastructures in which new forms of collaborative design can take place."

This conceptualisation, while arriving from the field of software engineering, with different types of users and problems, is a suggestive approach with which to tackle the challenge of rethinking design as congregations of complexly interrelated ongoing performances of dynamic systems, or ecologies. Complete and instantaneous solutions are impossible in such situations, especially when the challenge is that of redesigning the design practices and the designers themselves. Instead, methods of change should be gradual: accumulating expertise; constructing demonstrators; building evidence; developing workflows; establishing concepts, building communities and sharing knowledge.

On the other hand, in interactions with complex natural systems, especially those that have experienced severe modification, passive and gradual approaches might be insufficient. Often, it is necessary to conduct an invasive experiment to solicit a response that can be informative for future design. Radical imagination is also vital in the times of radical change and it is important to see how the limitations of human creativity can be simultaneously overcome and the power of this creativity amplified through broadly inclusive partnerships with nonhuman stakeholders. In resistance to unification driven by quantitative methods and common models, it is important to defend diverse design approaches even if this is inefficient because all human knowledge is destined to remain incomplete and all human models are simplifications, especially in the case of complex and inherently nondeterministic systems. By analogy with cultural diversity and biodiversity, the investment into the redundancy of envisioned futures will contribute to the robustness of the system, with multiple approaches tried in parallel, with possibilities for local adaptation supported by additional degrees of freedom and with opportunities for the expression of context-specific creativity intentionally preserved.

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In discussing the possible approaches to the rethinking of design, this chapter has employed an example that considered questions arising from the proposal to design artificial habitats to replace large old trees. Unusual but characteristic of future challenges, this example highlighted the need for further theoretical and practical work on design values, design participation and possible design methods.

The core tenets of the conceptual approaches outlined above can lead to a broad impact only through systematic deployment at multiple sites of practice. The emerging notions and techniques need to be actively integrated into the institutional education, manifest themselves via best-practice guidelines and be emphasized in disseminated project work. The positive outcomes of such integration will take form of improved design methods, supported across domains of knowledge, founded on shared conceptual frameworks and delivered to all, on demand. For example, the project that aims to propose artificial replacements for large old trees can be made more informed, more accountable and more influential if it is tackled as open-source and open-access speculative research that aims to produce specific solutions but also share tools for independent analysis, provide information to support external criticism and prepare practical kits of techniques that can be customized and redeployed elsewhere.

References:

Baine, Mark (2001). 'Artificial Reefs: A Review of Their Design, Application, Management and Performance', *Ocean and Coastal Management*, 44, 3/4, pp. 241–259

Bourdieu, Pierre (1990). *The Logic of Practice* (Stanford: Stanford University Press)

Bratton, Benjamin H. (2015). *The Stack: On Software and Sovereignty* (Cambridge, MA: MIT Press)

Browne, Mark A. and M. Gee Chapman (2011). 'Ecologically Informed Engineering Reduces Loss of Intertidal Biodiversity on Artificial Shorelines', *Environmental Science & Technology*, 45, 19, pp. 8204–8207

Bulleri, Fabio and M. Gee Chapman (2015). 'Artificial Physical Structures', in *Marine Ecosystems: Human Impacts on Biodiversity, Functioning and Services*, ed. by Christopher L. J. Frid and Tasman P. Crowe (Cambridge: Cambridge University Press), pp. 167–201

Burns, Colin, Hilary Cottam, Chris Vanstone, and Jennie Winhall (2006). *RED Paper 02: Transformation Design* (London: Design Council)

Cantrell, Bradley, Laura J. Martin, and Erle C. Ellis (2017). 'Designing Autonomy: Opportunities for New Wildness in the Anthropocene', *Trends in Ecology and Evolution*, 32, 3, pp. 156–166

Cordell, Ken H., John C. Bergstrom, and James M. Bowker, eds (2005). *The Multiple Values of Wilderness* (State College, PA: Venture Publishing)

Corlett, Richard T. (2016). 'Restoration, Reintroduction, and Rewilding in a Changing World', *Trends in Ecology & Evolution*, 31, 6, pp. 453–462

Cronon, William (1996 [1995]). 'The Trouble with Wilderness; or, Getting Back to the Wrong Nature', in *Uncommon Ground: Rethinking the Human Place in Nature*, ed. by William Cronon, paperback edn (New York; London: W.W. Norton & Co), pp. 69–90

Dawkins, Richard (1998). *Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder* (London: Allen Lane)

Fischer, Gerhard (2003). 'Meta-Design: Beyond User-Centered and Participatory Design', in *Proceedings of HCI International: Human-Computer Interaction: Theory and Practice*, ed. by Julie A. Jacko and Constantine Stephanidis, (Mahwah: Lawrence Erlbaum Associates), pp. 88–92

Fogg, Brian J. (2003). *Persuasive Technology: Using Computers to Change What We Think and Do* (Amsterdam; Boston: Morgan-Kaufmann)

Fry, Tony (2008). *Design Futuring: Sustainability, Ethics and New Practice* (Oxford: Berg)

Fry, Tony (2011). *Design as Politics* (Oxford: Berg)

Fry, Tony (2012). *Becoming Human by Design* (London: Berg)

Fuad-Luke, Alastair (2009). *Design Activism: Beautiful Strangeness for a Sustainable World* (London; Sterling, VA: Earthscan)

Galison, Peter L. (2000). 'An Accident of History', in *Atmospheric Flight in the Twentieth Century*, ed. by Peter Galison and Alex Roland (Dordrecht: Kluwer), pp. 3–44

Garson, Justin, Anya Plutynski, and Sahotra Sarkar, eds (2017). *The Routledge Handbook of Philosophy of Biodiversity*

Giaccardi, Elisa and Gerhard Fischer (2008). 'Creativity and Evolution: A Metadesign Perspective', *Digital Creativity Digital Creativity*, 19, 1, pp. 19–32

Gibbons, Philip, and David Lindenmayer (2002). *Tree Hollows and Wildlife Conservation in Australia* (Collingwood: CSIRO)

Gunter, Pete A. Y. (1985). 'Creativity and Ecology', in *Creativity in Art, Religion and Culture*, ed. by Michael H. Mitias (Amsterdam: Rodopi), pp. 107–116

Hallé, Francis., Roelof A. A. Oldeman, and Philip B. Tomlinson (1978). *Tropical Trees and Forests: An Architectural Analysis* (Berlin: Springer)

Harman, Graham (2005). *Guerrilla Metaphysics: Phenomenology and the Carpentry of Things* (Chicago: Open Court)

Hutchison, Abigail (2014). 'The Whanganui River as a Legal Person', *Alternative Law Journal*, 39, 3, pp. 179–182

Ikin, Karen, et al. (2015). 'Key Lessons for Achieving Biodiversity-Sensitive Cities and Towns', *Ecological Management & Restoration*, 16, 3, pp. 206–214

Ingersoll, Richard (2012). 'The Ecology Question and Architecture', in *The Sage Handbook of Architectural Theory*, ed. by C. Greig Crysler, Stephen Cairns, and Hilde Heynen (Los Angeles; London; New Delhi: Sage)

Jahn, Gwyllim, Thomas Morgan and Stanislav Roudavski (2014). 'Mesh Agency', in *Design Agency: Proceedings of the 34th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA)*, ed. by David Gerber, Alvin Huang and Jose Sanchez, pp. 135–144

Jelsma, Jaap (2000). 'Design of Behaviour-Steering Technology', in *Proceedings of the International Summer Academy on Technology Studies: Strategies of a Sustainable Product Policy*, ed. by Ursula Pretterhofer, (Graz: IFZ), pp. 121–132

Kerry, James T. and David R. Bellwood (2015). 'Do Tabular Corals Constitute Keystone Structures for Fishes on Coral Reefs?', *Coral Reefs*, 34, 1, pp. 41–50

Kolarevic, Branko and Kevin R. Klinger (2008). 'Manufacturing / Material / Effects', in *Manufacturing Material Effects: Rethinking Design and Making in Architecture*, ed. by anonymous (New York; London: Routledge), pp. 6–24

Le Roux, Darren S., et al. (2015). 'Enriching Small Trees with Artificial Nest Boxes Cannot Mimic the Value of Large Trees for Hollow-Nesting Birds', *Restoration Ecology*, 2, pp. 252–258

Low, Tim (2017 [2002]). *The New Nature* (Camberwell: Viking)

Manning, Adrian D., Joern Fischer, and David B. Lindenmayer (2006). 'Scattered Trees are Keystone Structures: Implications for Conservation', *Biological Conservation*, 132, 3, pp. 311–321

McKibben, Bill (2003 [1989]). *The End of Nature*, Rev. edn (London: Bloomsbury)

Merchant, Carolyn (2016). *Autonomous Nature: Problems of Prediction and Control from Ancient Times to the Scientific Revolution*

Mitsch, William J. (2014). 'When Will Ecologists Learn Engineering and Engineers Learn Ecology?', *Ecological Engineering Ecological Engineering*, 65, , pp. 9–14

Odling-Smee, F. John, Kevin N. Laland, and Marcus W. Feldman (2003). *Niche Construction: The Neglected Process in Evolution* (Princeton, NJ; Woodstock: Princeton University Press)

Odling-Smee, John and J. Scott Turner (2011). 'Niche Construction Theory and Human Architecture', *Biological Theory*, 6, 3, pp. 283–289

Odum, Howard T. (2007). *Environment, Power, and Society for the Twenty-First Century: The Hierarchy of Energy* (New York: Columbia University Press)

Roudavski, Stanislav and Gwyllim Jahn (2016). 'Activist Systems: Futuring with Living Models', *International Journal of Architectural Computing*, 16, 2, pp. 182–196

Sanders, Liz, and Pieter Jan Stappers (2012). *Convivial Toolbox: Generative Research for the Front End of Design* (Amsterdam: BIS)

Sardar, Ziauddin (2010). 'Welcome to Postnormal Times', *Futures*, 42, 5, pp. 435–444

Sless, David (2012). 'Design or "Design"—Envisioning a Future Design Education', *Visible Language*, 46, 1–2, pp. 54–65

Tews, Jörg, et al. (2004). 'Animal Species Diversity Driven by Habitat Heterogeneity/Diversity: The Importance of Keystone Structures', *Journal of Biogeography*, 31, 1, pp. 79–92

Tonkinwise, Cameron (2014). 'Design Away', in *Design as Future-Making*, ed. by Susan Yelavich and Barbara Adams (London: Bloomsbury), pp. 198–213

Turner, J. Scott (2000). *The Extended Organism: The Physiology of Animal-Built Structures* (Cambridge, MA; London: Harvard University Press)

Turner, J. Scott and Rupert C. Soar (2008). 'Beyond Biomimicry: What Termites Can Tell Us about Realizing the Living Building', in *First International Conference on Industrialized, Intelligent Construction (I3CON)*, ed. by Tarek Hassan and Jilin Ye, pp. 221–237

Van der Ryn, Sim, and Stuart Cowan (2007 [1996]). *Ecological Design*, 10th anniversary edn (Washington: Island Press)

Vellend, Mark (2010). 'Conceptual Synthesis in Community Ecology', *The Quarterly Review of Biology*, 85, 2, pp. 183–206

Wapner, Paul Kevin (2010). *Living through the End of Nature: The Future of American Environmentalism* (Cambridge, MA: MIT Press)

Willis, Anne-Marie (2007). 'Ontological Design - Laying the Ground', in *Design Philosophy Papers Collection Three*, ed. by Anne-Marie Willis (Ravensbourne: Team D/E/S Publications), pp. 80–98

Wood, John (2007). *Design for Micro-Utopias: Making the Unthinkable Possible* (Aldershot: Gower)

Wood, John (2008). 'Changing the Change: A Fractal Framework for Metadesign', in *Changing the Change: Design, Visions, Proposals and Tools*, ed. by Carla Cipolla and Pier Paolo Peruccio (Turin: Allemandi), pp. 1–8